

584503

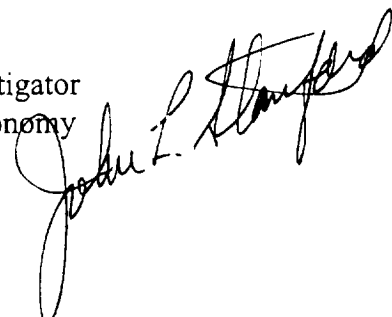
Final Report for

Atmospheric Dynamics Deduced From UARS Using  
Middle Atmosphere ISAMS Carbon Monoxide and Upper-  
Tropospheric MLS Water Vapor and Ice Data  
Grant NAG5-7133

UARS Science Investigator Program  
National Aeronautics & Space Administration  
Washington, DC

John L. Stanford, Principal Investigator  
Department of Physics and Astronomy  
Iowa State University  
Ames, Iowa 50011-3160

May 31, 2002



#### OVERVIEW:

This project involved analyses of atmospheric constituent data fields, carbon monoxide in the upper stratospheric/lower mesosphere, and water vapor in the upper troposphere. The observational data analyses were compared with atmospheric models.

## RESULTS:

This grant provided partial support for two papers published in refereed scientific journals. The first paper deals with analyses of carbon monoxide in the autumn/winter Antarctic polar mesosphere and middle stratosphere. This was the first detailed analysis and model comparison for UARS ISAMS carbon monoxide observations.

The second aspect of the grant dealt with upper troposphere water vapor measurements. A particular focus was to explain the sometimes-observed poor correlation between potential vorticity and UARS MLS upper-tropospheric water vapor observations. The second paper below demonstrated that parcel trajectories can undergo potential vorticity destruction, from several physical mechanisms, while conserving constituents such as water vapor and ozone.

Students supported in part by the grant include Mark Olsen (Ph.D., 2000) and Melissa Goering (M.S., 2001).

### Papers:

1. "Antarctic polar descent and planetary wave activity observed in ISAMS CO from April to July 1992"

Geophysical Review Letters, vol. 27, pp 665-668 (2000)

D. R. Allen and N. Nakamura, Department of Geophysical Sciences, University of Chicago, Chicago, IL

J. L. Stanford, Department of Physics and Astronomy, Iowa State University, Ames, IA

M. A. Lopez-Valverde and M. Lopez-Puertas, Instituto de Astrofísica de Andalucía (CSIC), Granada, Spain

F. W. Taylor and J. J. Remedios, Department of Physics, Oxford University, Oxford, United Kingdom

### Abstract

Antarctic polar descent and planetary wave activity in the upper stratosphere and lower mesosphere are observed in ISAMS CO data from April to July 1992. CO-derived mean April-to-May upper stratosphere descent rates of 15 K/day at 60 S and 20 K/day at 80 S are compared with descent rates from diabatic trajectory analyses. At 60 S there is excellent agreement, while at 80 S the trajectory-derived descent is significantly larger in early April. Zonal wavenumber 1 enhancement of CO is observed on 9 and 28 May, coincident with enhanced wave 1 in UKMO geopotential height. The 9 May event extends from 38 to 68 km and shows westward phase tilt with height, while the 28 May event extends from 40 to 50 km and shows virtually no phase tilt with height.

2. "Evidence of stratosphere-to-troposphere transport within a mesoscale model and Total Ozone Mapping Spectrometer total ozone"

J. Geophys. Rev., 106, 27,323-27,334 (2001)

Mark A. Olsen and John L. Stanford

Department of Physics & Astronomy, Iowa State University, Ames, Iowa 50011

Abstract

We present evidence for stratospheric mass transport into, and remaining in, the troposphere in an intense midlatitude cyclone. Mesoscale forecast model analysis fields from the Mesoscale Analysis and Prediction System (MAPS) were compared with total ozone observations from the Total Ozone Measurement Spectrometer (TOMS). Coupled with parcel back-trajectory calculations, the analyses suggest two mechanisms contributed to the mass exchange: (1) A region of dynamically-induced exchange occurred on the cyclone's southern edge. Parcels originally in the stratosphere crossed the jet core and experienced dilution by turbulent mixing with tropospheric air. (2) Diabatic effects reduced parcel potential vorticity (PV) for trajectories traversing precipitation regions, resulting in a "PV-hole" signature in the cyclone center. Air with lower-stratospheric values of ozone and water vapor was left in the troposphere. The strength of the latter process may be atypical. These results, combined with other research, suggest that precipitation-induced diabatic effects can significantly modify (either decreasing or increasing) parcel potential vorticity, depending on parcel trajectory configuration with respect to jet core and maximum heating regions. In addition, these results underscore the importance of using not only PV but also chemical constituents for diagnoses of stratosphere-troposphere exchange (STE).

---

Copies of this report are being sent to:

Dr. Anne R. Douglas  
Code 916  
Goddard Space Flight Center  
Greenbelt, MD 20771

Dr. Mark R. Schoeberl  
Code 916  
Goddard Space Flight Center  
Greenbelt, MD 20771

Dr. Charles H. Jackman  
Code 916  
Goddard Space Flight Center  
Greenbelt, MD 20771

Dr. Jack Kaye, Director  
Research Division  
Code YS  
NASA Headquarters  
Washington, DC 20546-0001

-

Two Copies are being sent to NASA Center for Aerospace Information (CASI), 7121 Standard Drive, Hanover, MD 21076-1320.

cc: Adrian R. Jefferson  
Grant Negotiator  
Code 216  
NASA Goddard Space Flight Center  
Greenbelt, MD 20771

Diane Smith  
Physics Administrator  
12 Physics  
Iowa State University  
Ames, IA 50011-3160

Thane Peterson  
Sponsored Program Administration  
2207 Pearson Hall, Room 15  
Iowa State University  
Ames, IA 50011

Closeout Unit  
Office of Naval Research  
Chicago Regional Office  
536 South Clark Street, Room 208  
Chicago, IL 60605